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(54) **HIGH SPEED-PERFORATING APPARATUS**

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Jun. 12, 2000	(JP)	2000-176035

(51) **Int. Cl.**[7] **B23B 35/00**; B23B 41/00

(52) **U.S. Cl.** .... **409/132**; 408/1 R; 408/56; 408/124; 408/204; 175/403; 409/231

(58) **Field of Search** .... 175/58, 244, 403; 408/1 R, 56, 57, 68, 124, 144, 145, 204; 409/231, 233, 132

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(57) **ABSTRACT**

Disclosed is a high speed-perforating apparatus **1** comprising a rotor **17** into and through which a cylindrical rotary shaft **11** is integrally inserted, a stator **18** disposed around the outer periphery of the rotor **17** and a core bit **13** which is directly connected to the head end portion of the rotary shaft. A bit **15** having an outer diameter of up to 40 mm and a cutting edge thickness of less than 2 mm is used for the core bit **13**. Perforation is carried out by the core bit **13** which is rotated at a high speed of 4000 rpm or more by a direct motor **2** comprising the rotor **17** and the stator **18**. A perforating time can be greatly shortened by rotating the core bit at high speed.

20 Claims, 9 Drawing Sheets

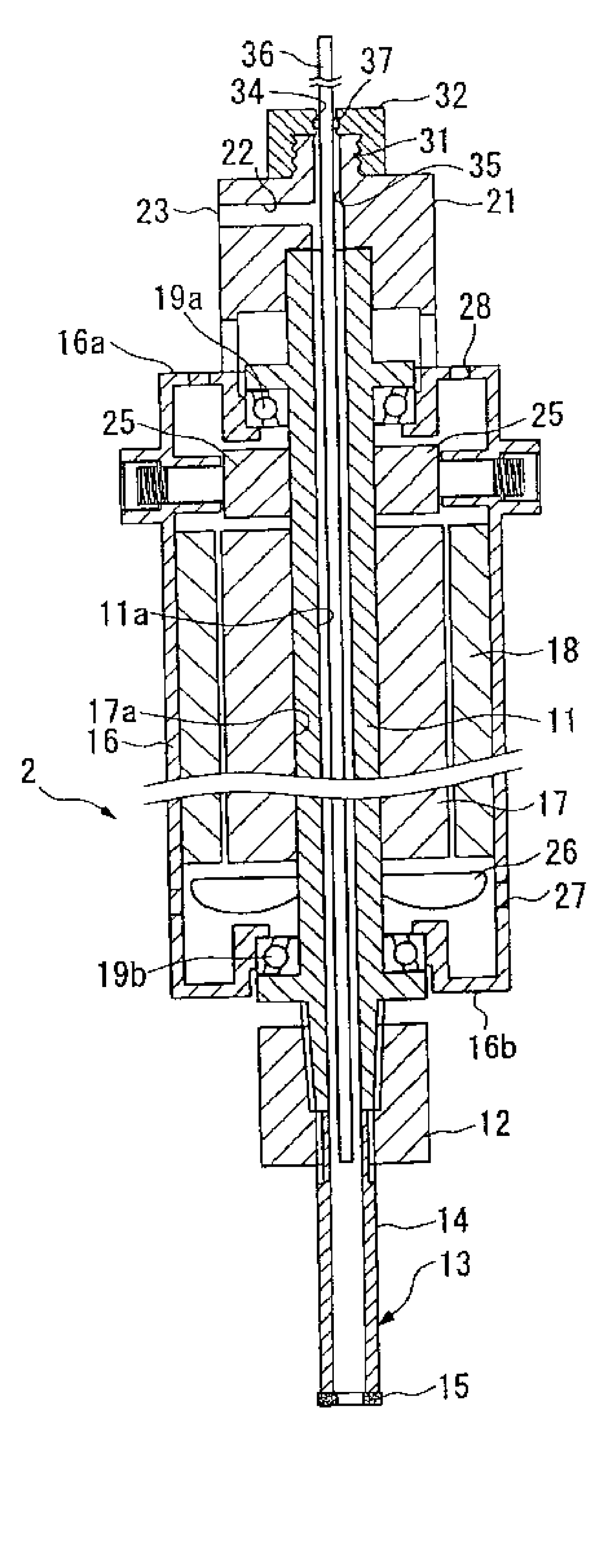


FIG. 1

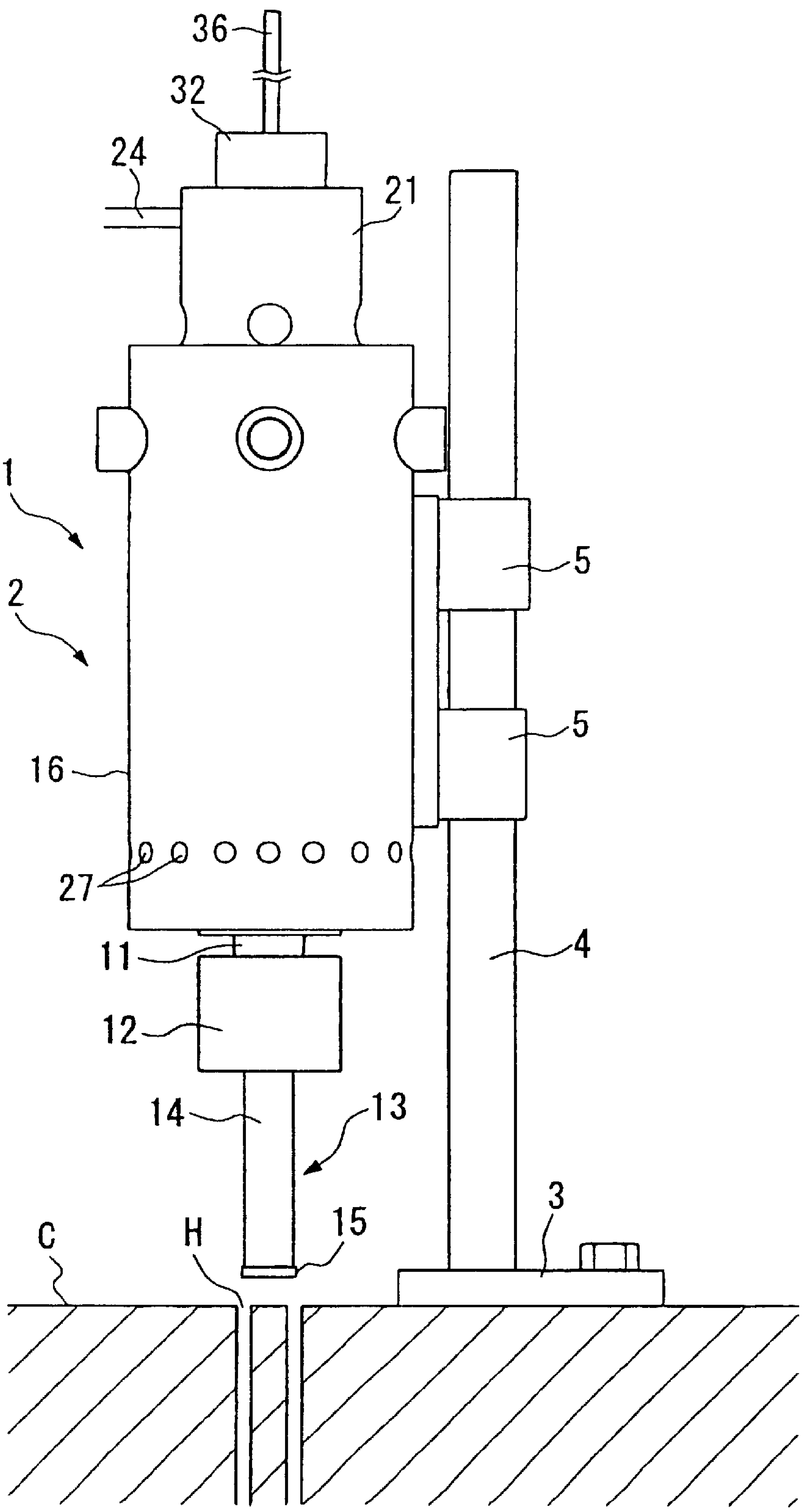
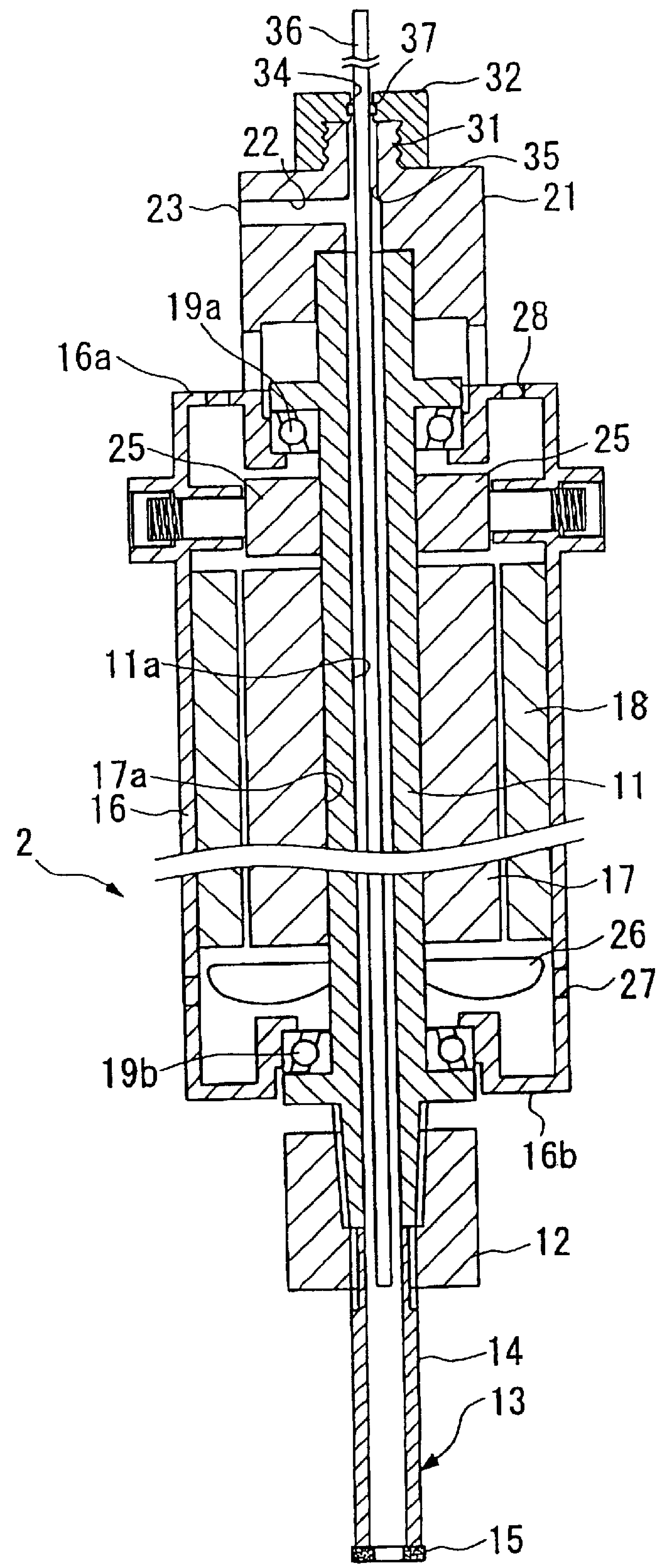


FIG. 2


36
37
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19a
28
16a
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26
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19b
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12
14
13
15

FIG. 3

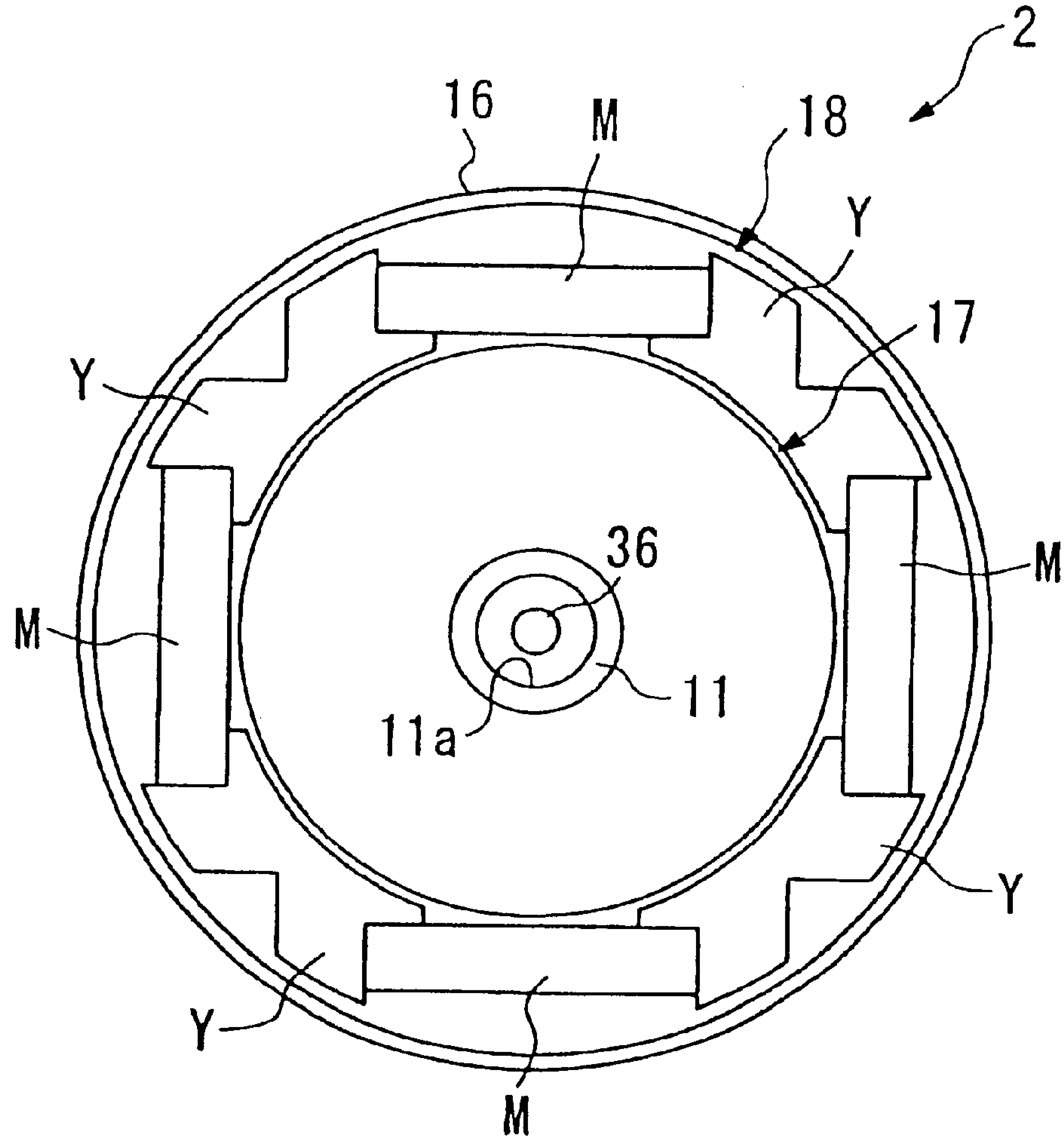


FIG. 4

(RESULT OF TEST)

Switchover of rotation	Actual rotational speed rpm	Perforating time sec	Distance of sound measurement m	Noise dB
Low speed	2000-3500	49.00	1	71
	2000-3500	44.57	2	75.1
	2000-3500	43.92	3	74.7
High speed	5700-6300	26.00	1	77.9
	4900-6100	24.58	2	76.4
	4700-6100	24.37	3	75.6

FIG. 5

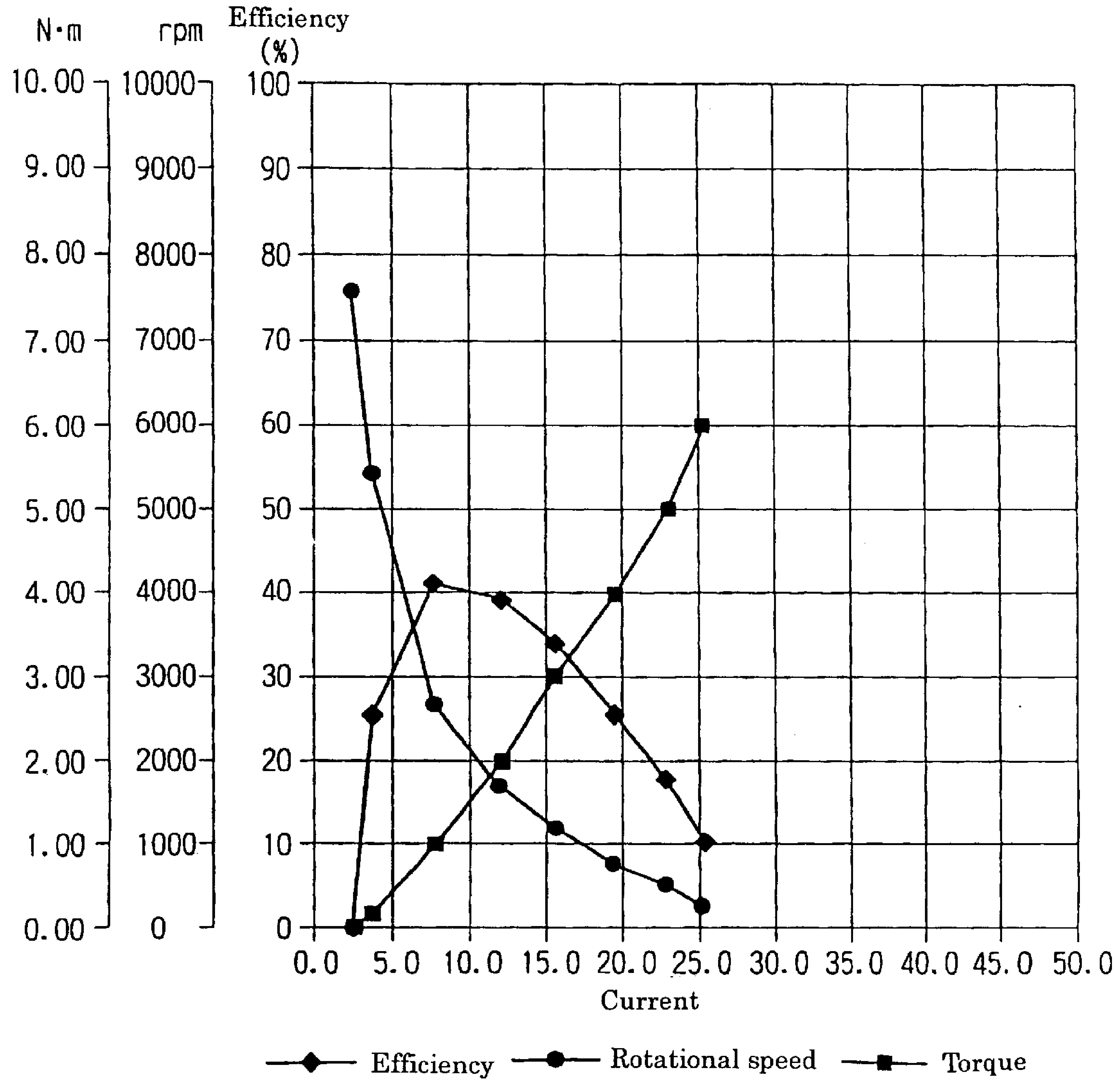

N·m
rpm
Efficiency (%)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
100
90
80
70
60
50
40
30
20
10
0
0.0 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0
Current
Efficiency
Rotational speed
Torque

FIG. 6

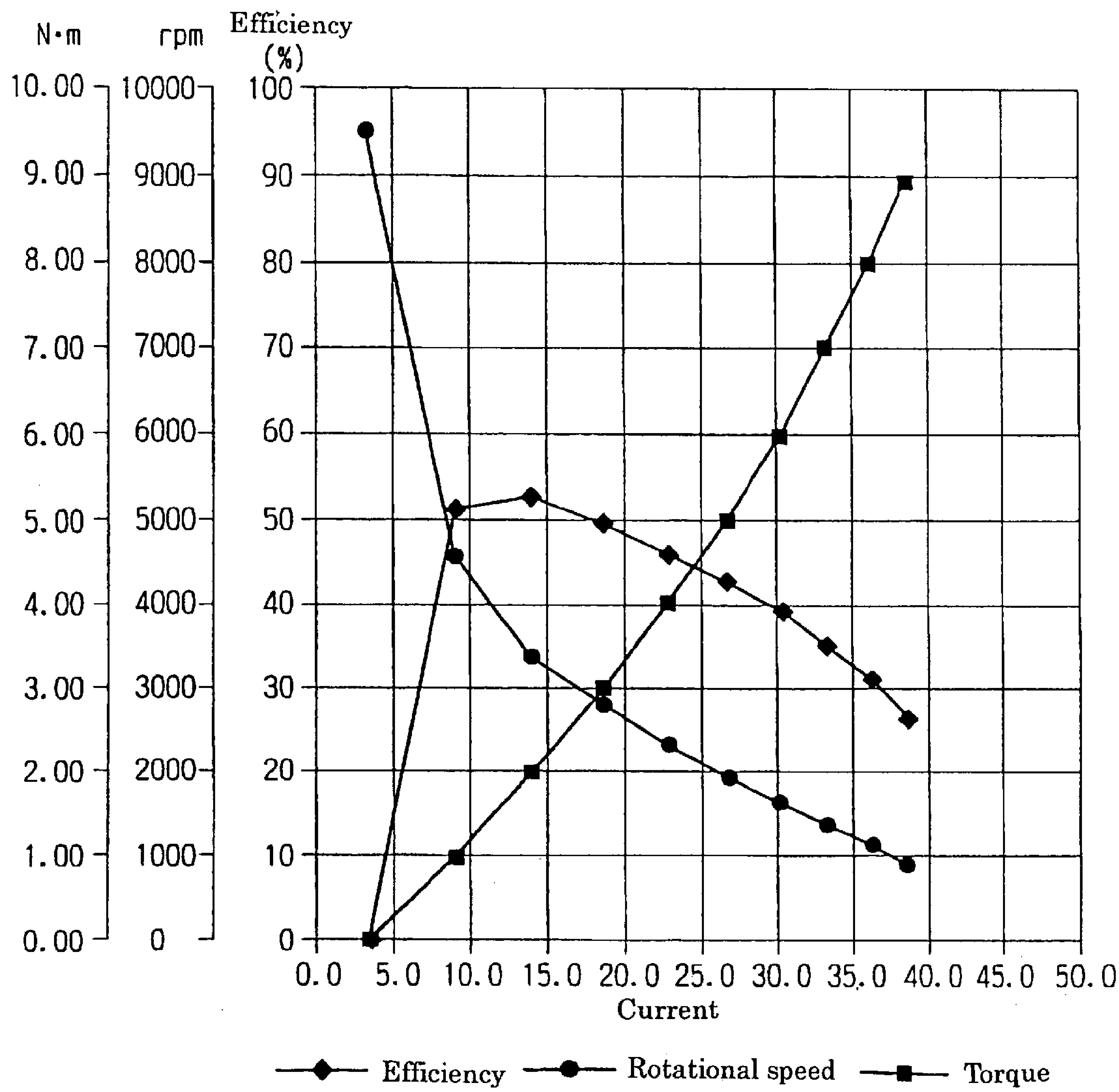

N·m
rpm
Efficiency (%)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
100
90
80
70
60
50
40
30
20
10
0
0.0 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0
Current
Efficiency
Rotational speed
Torque

FIG. 7

	Circumferential speed m/min	Perforating time sec	Noise dB	Cutting efficiency m^3/sec
Direct motor	289	24	72	261
Conventional electric motor	66	139	82	56

FIG. 8

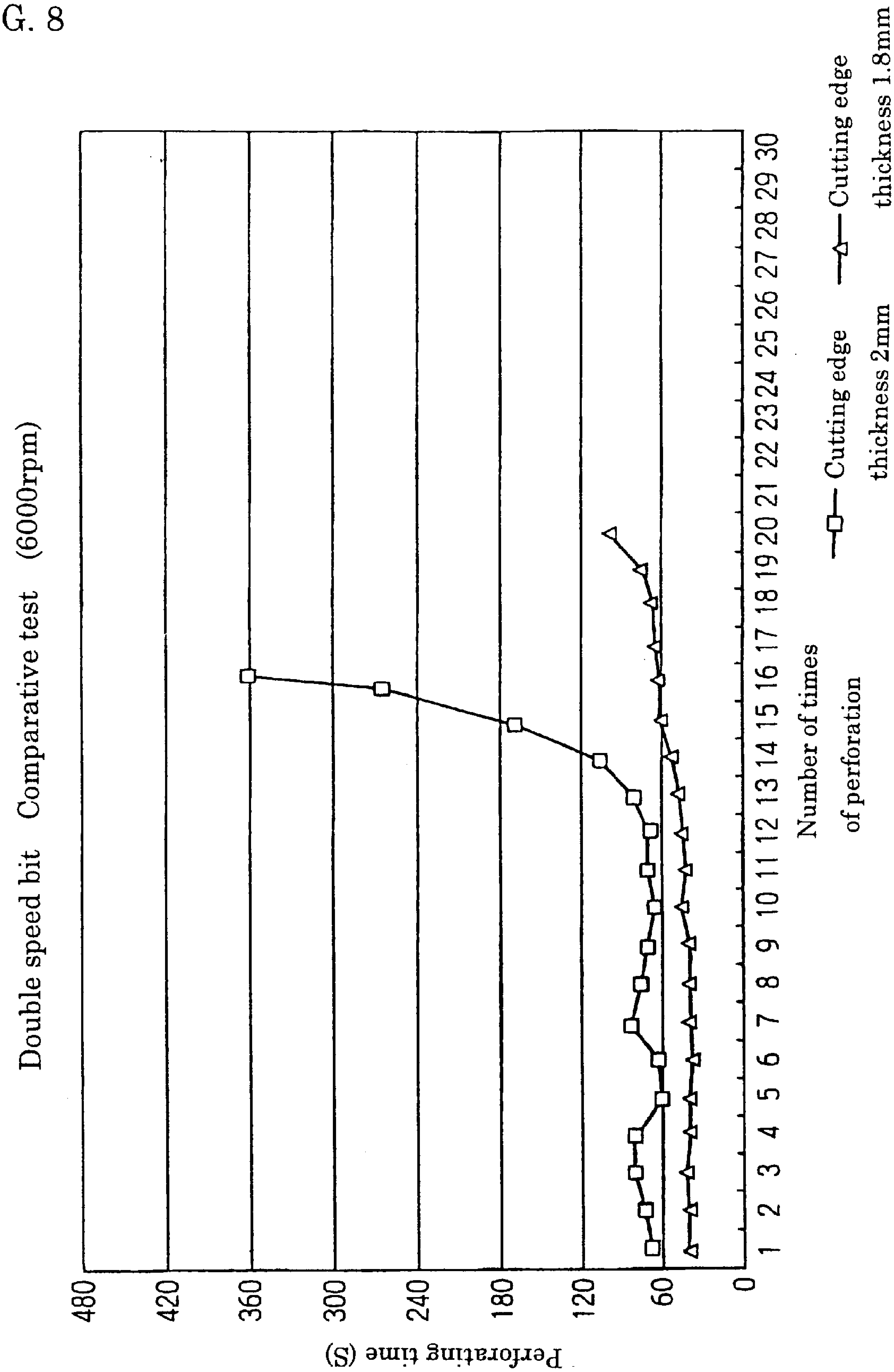
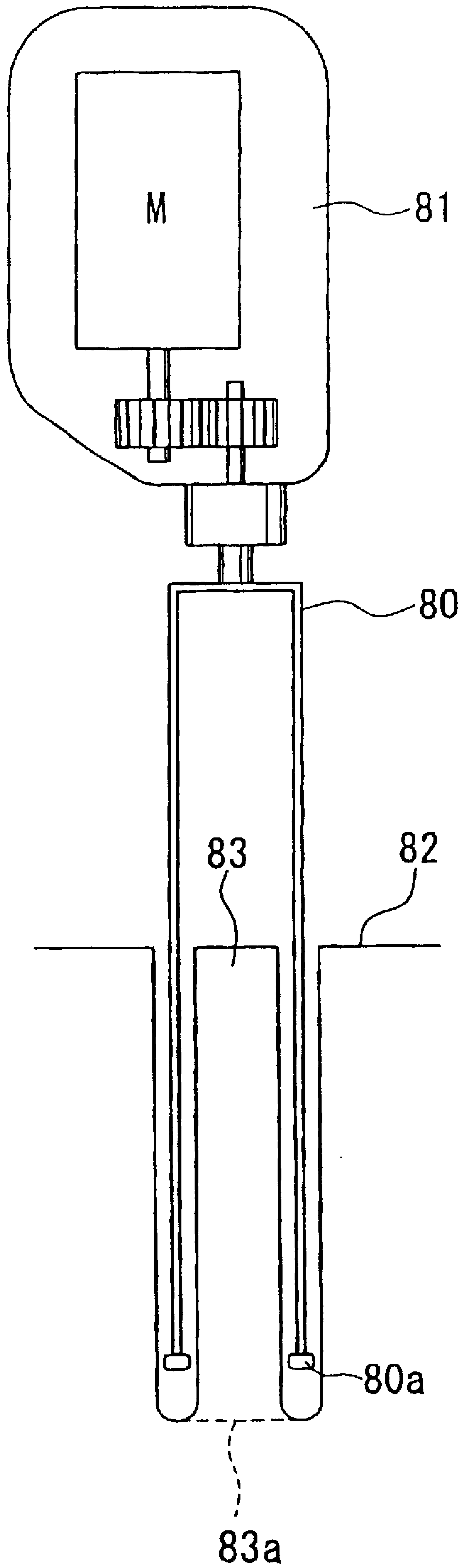

Double speed bit Comparative test (6000rpm)
Perforating time (S)
0
60
120
180
240
300
360
420
480
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Number of times of perforation
Cutting edge thickness 2mm
Cutting edge thickness 1.8mm

FIG. 9



HIGH SPEED-PERFORATING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a high speed-perforating apparatus which bores annular holes in a material to be perforated comprising a concrete structure at high speed, for example, when anchors and the like are set up for the post-construction of the concrete structure.

The present specification is based on Japanese patent applications (No. HEI 11-301753, HEI 2000-049943, HEI 2000-176035) and the contents of these applications are incorporated herein.

2. Description of the Related Art

For strengthening an existing wall made of concrete, the following method is known: first, a hole having a large size is made in the wall to provide an opening; next, a brace (diagonal brace) made of iron is provided in the opening thus made; and then the brace and anchors disposed in the inward peripheral face of the opening are consolidated with concrete, to thereby strengthen all over wall. In this case, each anchor is received in a hole arranged in the inward peripheral face and set up therein.

The hole for setting up an anchor is formed by using an apparatus which comprises a core bit **80** having an annular bit **80***a* composed of diamond tip, cemented carbide tip or the like in the end of a cylindrical member, and a motor **81** for rotating the core bit **80** around the axis thereof, as shown in FIG. **9**.

Namely, a core **83** having a columnar shape is formed by rotating the bit **80***a* provided in the end of the core bit **80** while the bit **80***a* is pressed against a concrete **82** to be perforated therein, followed by pulling out the core bit **80** from the inside of the concrete **82**.

Then, the core **83** left in the inside of the concrete **82** is pulled out after breaking off the root thereof, whereby a hole having, for example, a degree of size-a diameter of 20 to 35 mm and a depth of 200 mm is formed for setting up an anchor.

In the above-mentioned apparatus, the motor **81** is heavy and lack of easy handling as in engines oil-hydraulic motors, or the like, because the motor **81** comprises gears through which the core bit **80** is rotated. In addition, the apparatus has a problem in generating a big noise (more than 90 dB). Further the apparatus has problems in that the number of revolution is as low as about 1500 rpm even at high speed and a maximum number of revolution is a degree of 3000 to 3900 rpm even in the case of special electric motors, whereby it takes a long time to perforate.

Ultrasonic perforating apparatus which perforate by ultrasonics can perforate with a comparatively low noise and on the other hand the perforating speed thereof is slow, to thereby take a long time to perforate as in the case of the above-mentioned apparatus having a motor.

Though a perforating time can be shortened by thinning the cutting edge thickness of the bit **80***a* of the core bit **80**, there is a problem in that a tool load imposed on the bit **80***a* is increased and a force directed to a perforating direction (normal force) is increased, both due to thinning the cutting edge thickness, to thereby bring out the buckling of the core bit **80**.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a high-speed perforating apparatus which can perforates within a short time at a high revolution without buckling a core bit attached thereto, accompanied by a low noise.

The high-speed perforating apparatus of the present invention comprises a cylindrical core bit having a bit for boring an annular hole in a material to be perforated and a motor having a cylindrical stator disposed around the outer periphery of a cylindrical rotor into and through which a rotary shaft is inserted and to which the same is fixed, wherein the core bit is directly attached to the rotary shaft of the motor without transmission means such as gear, belt or the like and is directly rotated at high speed by the motor.

Accordingly, in the high-speed perforating apparatus of the present invention, a perforating speed can be greatly increased, as compared with the conventional apparatus which perforates at low speed.

Thereby, working for perforation can be rapidly carried out to shorten terms for various construction works having perforating works.

Further, in the high-speed perforating apparatus of the present invention, noise can be greatly reduced (about 70 dB) and as the number of parts are small, labors necessary for maintenance works can be greatly reduced, as compared with engines, oil-hydraulic motors and electric motors having gears.

As mentioned above, a tool load imposed on a bit can be decreased by rotating a core bit at high speed, whereby even when the cutting edge thickness of the bit is thin, a normal force which is directed to a perforating direction can be small, perforation can be smoothly carried out without troubles such as buckling while always maintaining a good cutting performance, and a perforating time can be reduced.

The method for a high-speed perforation of the present invention comprises the steps of: providing for a motor having a cylindrical rotor into and through which a rotary shaft is inserted and to which the same is fixed and having a cylindrical stator disposed around the outer periphery of the cylindrical rotor; attaching directly to the rotary shaft of the motor a cylindrical core bit having a bit for boring an annular hole in a material to be perforated without transmission means such as gear, belt or the like; and rotating directly the core bit at high speed by rotating the rotary shaft, to thereby bore a hole in the material to be perforated with the bit.

Accordingly, a perforating speed can be greatly increased, as compared with the conventional perforating method carried out at low speed.

Whereby, working for perforation can be rapidly carried out to shorten terms for various construction works having perforating works.

Further, in the method for a high-speed perforation of the present invention, noise can be greatly reduced (about 70 dB) and as the number of parts are small, labors necessary for maintenance works can be greatly reduced, as compared with engines, oil-hydraulic motors and electric motors having gears.

As mentioned above, a tool load imposed on a bit can be decreased by rotating a core bit at high speed, whereby even when a bit having a thin cutting edge thickness is used, a normal force which is directed to a perforating direction can be small, perforation can be smoothly carried out without troubles such as buckling while always maintaining a good cutting performance and a perforating time can be reduced.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a side view of a high-speed perforating apparatus showing an example of the high-speed perforating apparatus of the present invention.

FIG. **2** is a sectional view illustrating a structure of direct motor which is used for the high-speed perforating apparatus of the present invention.

FIG. **3** is a cross-sectional view of a direct motor illustrating a structure of direct motor which is used for the high-speed perforating apparatus of the present invention.

FIG. **4** is a table showing perforating times and noise when a hole is bored in concrete.

FIG. **5** is a graph showing the performance of a direct motor which is used in the method for a high-speed perforation of the present invention.

FIG. **6** is a graph showing the performance of a direct motor which is used in the method for a high-speed perforation of the present invention.

FIG. **7** is a table showing perforating times, noise and cutting efficiency when a hole is bored in concrete.

FIG. **8** is a graph showing the results of test for perforation when the perforation is carried out using bits having different cutting edge thickness.

FIG. **9** is a sectional view illustrating the structure of the conventional perforating apparatus.

DESCRIPTION OF PREFERRED EMBODIMENTS

The high-speed perforating apparatus of the present invention is described in detail hereunder, referring to drawings.

In FIGS. **1** and **2**, a symbol **1** shows a high-speed perforating apparatus and a symbol **2** shows a direct motor composing the high-speed perforating apparatus **1**. The high-speed perforating apparatus **1** has the following construction: the direct motor **2** is supported through an up and down-moving means **5** by a column **4** which is attached to a base **3** such that the column stands on the base; and the direct motor **2** can be moved along the column **4** by moving the up and down-moving means **5**.

The direct motor **2** comprises a rotary shaft **11** having a cylindrical shape in the center thereof. A core bit **13** is connected to the head end portion of the rotary shaft **11** by aid of an adapter **12** such that the core bit can be attached to and detached from the rotary shaft. The core bit **13** comprises a bit **15** composed of diamond bit which is integrally provided in the head end portion of a tube **14** having a hollow shape and in the circumferential direction thereof.

Namely, the direct motor **2** is a type of direct motor wherein the core bit **13** is directly rotated which is a tool connected directly to the rotary shaft **11**.

The core bit **13** comprises a bit **15** disposed in the end of the tube **14** and composed of a diamond tool which is produced by consolidating cemented carbides or superabrasives (diamond abrasive grains, CBN abrasive grains) with binders such as metal bond, resin bond or the like. A concrete C can be perforated and a columnar core can be formed by rotating the core bit.

A core bit **13** having an outer diameter of up to 40 mm can be used and preferable is an outer diameter of 15 to 30 mm. With regard to the cutting edge thickness of the bit **15**, a thickness of less than 2.0 mm can be used and preferable is 1.8 mm.

The direct motor **2** comprises; a rotor **17** into and through which a rotary shaft **11** is inserted and to which the same is integrally fixed; and a stator **18** having a cylindrical shape disposed around the outer periphery of the rotor **17**, wherein both of the rotor and stator are disposed in a housing **16** of the motor.

The rotary shaft **11** is inserted into and through an inserting hole **17***a* formed in the center of the rotor **17** and is integrally fixed to the rotor by press-inserting into the inserting hole **17***a*.

As shown in FIG. **3**, the stator **18** comprises magnets M disposed at some spaces in the circumferential direction and yokes Y made of steel which are disposed between the magnets M and support the magnets M in a prescribed position.

Bearings **19***a* and **19***b* are provided in the insides of the upper wall portion **16***a* and the under wall portion **16***b* of the housing **16** for supporting the rotor **17** in such a manner that the rotor **17** can be freely rotated. That is, the bearings **19***a* and **19***b* are provided to have such a construction that the bearings can support each vicinity of the upper and under portions of the rotary shaft **11** which is inserted into and through the center of the rotor **17** and can receive thrust and radial forces imposed upon the rotary shaft **11** and the rotor **17** into and through which the rotary shaft **11** is inserted.

A rotary joint **21** is provided in the back end portion of the direct motor **2**. The rotary joint **21** is attached to the upper wall portion **16***a* of the housing **16** and is connected to the back end portion of the rotary shaft **11** in such a manner to be rotatable and liquid-sealed.

In the rotary joint **21**, a flow line **22** is formed which is connected to the through hole **11***a* of the center of the rotary shaft **11** and is opened to the side of the rotary joint **21**. A tube **24** is connected to an opening **23** which is opened in the above-mentioned side and a cooling water is supplied from the tube **24**.

The cooling water which is supplied from the tube **24** to the flow line **22** of the rotary joint **21** passes the flow line **22** of the rotary joint **21** and then is introduced into the through hole **11***a* of the rotary shaft **11**, and after that, is introduced into the tube **14** of the core bit **13** connected to the head end portion of the rotary shaft **11** by aid of the adapter **12**, thereby cooling a portion which is perforated by the bit **15**.

In the rotary joint **21**, a setting screw **31** is formed in the back end portion thereof and a cap **32** is screw-clamped to the setting screw **31**. An inserting hole **34** is formed in the center of the cap **32**. Further, in the rotary joint **21**, a connecting hole **35** is formed which connects the inserting hole **34** of the cap **32** and the through hole **11***a* of the rotary shaft **11**. And an extruding bar **36** is inserted into and through the inserting hole **34**, the connecting hole **35** and the through hole **11***a* which are connected each other. An O-ring **37** is provided between the extruding bar **36** and the cap **32** to form a seal.

Further, in the direct motor **2**, a cooling fan **26** is provided in the head end portion of the rotary shaft **11**, and air is introduced into the housing **16** from an inlet **27** formed in the head end side of the housing **16** by rotating the rotary shaft **11** and is sprayed to the inside of the direct motor **2**. Then, air is introduced a gap between the stator **18** and the rotor **17** and a vacant space between the magnets M and yokes Y of the stator **18** and the housing **16**, followed by being exhausted to the outside from an outlet **28** which is formed in the upper wall portion **16***a* of the housing **16**.

A symbol **25** is a brush disposed in the circumferential direction of the rotary shaft **11** in such a manner that the brush contacts the rotary shaft **11** in the upper side of the inside of the housing **16** of the direct motor **2**, and a driving current is supplied from the brush **25**.

As the magnet M of the stator **18**, high-density rare-earth magnets such as neodymium·iron·boron magnets or samarium·cobalt magnets are used which have a maximum magnetic energy product far higher than ferrite magnets or alnico magnets which are conventionally used.

With regard to a direct motor **2** comprising a rotor **17** and a stator **18**, any one of motors with brush and brushless motors can be used. In addition, in the above-example, the magnets M are provided in the stator **18** and the coil is provided in the rotor **17**. However, the coil can be provided in the stator **18** and the magnets can be provided in the rotor **17**, or both of the rotor and stator can be coils.

Next, a case is explained hereunder, wherein a hole is bored in a concrete C to be perforated using a high speed-perforating apparatus **1** having the above-mentioned construction.

First, the direct motor **2** disposed in the upper side of the column **4** is adjusted to have such a position that an axis of the rotary shaft **11** coincides with a prescribed position to be perforated in the concrete C, followed by fixing the base **3** to the concrete C.

After setting the high speed-perforating apparatus **1** on the concrete C as mentioned above, the coil of the rotor **17** (or the stator **18**) of the motor **2** is turned on electricity to rotate the rotor **17** at a high speed which is about 4000 rpm or more together with supplying a cooling water through the tube **24** from an apparatus for supplying cooling water (a cooling water source) which is not shown in Figs.

In the above-mentioned state, the bit **15** of the core bit **13** which is connected to the head end portion of the rotary shaft **11** is pressed against the surface of the concrete C by moving the direct motor **2** downward with the moving means **5**. An annular hole H is bored in the concrete C by the bit **15** which is rotated at high speed, following the above-mentioned process.

After the annular hole H is bored to a prescribed depth, the motor **2** is moved upward to take out the bit **15** from the hole H, followed by removing the core formed in the center of the hole, to thereby form an anchor hole.

In a case where the core is left in the core bit **13** when the bit **15** is taken out from the hole H by moving the direct motor **2** upward, the extruding bar **36** is extruded to the head end portion thereof, thereby to enable to quite easily extrude the core left in the inside of the core bit **13** from the end side of the core bit **13**.

According to the direct motor **2** having a construction mentioned above, the core bit **13** attached to the rotary shaft **11** is directly rotated by rotating the rotary shaft **11** without the aid of transmission means such as gear, belt and so on, with the result that the transmission loss can be removed and the perforating apparatus can be miniaturized and be made light-weighted as compared with motors having gears, to thereby increase the convenience in handling thereof, and that, the run out of the rotary shaft **11** can be minimized. Further, noise generated therefrom can be decrease to a minimum level.

Namely, as the bit **15** arranged in the head end portion of the core bit **13** is rotated by the direct motor **2**, the rotary shaft **11** of which directly provides a rotating force to the core bit **13**, the bit is rotated at a quite high speed (4000 rpm or more), to thereby enable to provide a quite high circumferential speed to the bit **15**. That is, as the bit **15** can be rotated at high speed as mentioned above, a tool load on the bit **15** can be reduced, whereby a normal force can be reduced which is loaded to a perforating direction and a perforating time can be decreased even when the cutting edge thickness of the bit **15** is as thin as less than 2 mm.

Furthermore, as magnets provided to any one of the rotor **17** and the stator **18** are high-density rare-earth magnets such

as neodymium·iron·boron magnets or samarium·cobalt magnets, the rotor **17** or the stator **18** can be miniaturized, to thereby enable to attain a further miniaturization and light-weight thereof.

The rigidity of the apparatus can be greatly increased over the whole as an integration is provide in such a manner that the rotary shaft **11** is press-inserted into the inserting-hole **17***a* which is formed in the center of the rotor **17** to directly fix the rotary shaft to the rotor, to thereby enable to form a hole by rotating the core bit **13** at high speed and to greatly increase a perforating speed as compared with the conventional perforating method which is carried out at low speed using the conventional perforating apparatus.

Thereby, work for perforation can be rapidly carried out to shorten terms for various construction works having perforating works.

Furthermore, noise can be greatly reduced (about 70 dB) and as the number of parts are small, labors necessary for maintenance works can be greatly reduced, as compared with the cases where engines, oil-hydraulic motors and motors having gears are used.

Still further, as the through hole **11***a* is formed in the center of the rotary shaft **11**, a cooling water or cooling air can be supplied from the back end portion of the rotary shaft **11** to the bit **15** which is an edge of cutter of the core bit **13** to enable to carry out an excellent perforation.

Yet further, the core bit **13** can be easily exchanged for a core bit having a different diameter by attaching and detaching the core bit **13** by aid of the adapter **12**, to thereby enable to easily carry out maintenance works such as the exchange of the core bit **13** and to increase the work efficiency thereof. In addition, as the core bit **13** is exchangeable, any bit for the bit **15** can be selected from ones having various cutting edge thickness and various shapes.

EXAMPLES

Test examples of a high speed-perforating method are explained hereunder, wherein the direct motor **2** mentioned above is used.

Test Example 1

Perforating times and noise were measured when annular holes H having a depth of 150 mm and a diameter of 25 mm were formed in a concrete C by rotating a bit **15** comprising a diamond tool at low speed and high speed with a direct motor **2**, the results of which are shown in FIG. **4**.

As shown in FIG. **4**, it was found that when carried out at high rotational speed, the perforating times decreased to the extent of about a half, as compared with low rotational speed. With regard to noise, it was found to be the level of 70 dB regardless of a speed which is high or low.

FIGS. **5** and **6** show the performance of a direct motor **2** used in the present test example.

FIG. **5** shows the results of the cases where low rotational speed was employed when load was imposed. FIG. **6** shows the results of the cases where high rotational speed was employed when load was imposed.

As is clear from FIG. **5**, in the case of low speed (about 3000 rpm), torque was a degree of about 1 Nm and as is clear from FIG. **6**, in the case of high speed (about 6000 rpm), torque was a degree of about 0.7 Nm.

Accordingly, it was found that when holes H were formed at high rotational speed, the torque was small as compared with low rotational speed.

Test Example 2

Holes H having a diameter of 25 mm (bit diameter 25 mm) and a depth of 200 mm were formed with a bit **15** comprising a diamond tool, using the conventional electric motor and the direct motor **2**. Each number of revolution was as follows: 950 rpm for the electric motor; 5980 rpm for the direct motor.

The results showed that a perforating time was 1 min. 25 sec. for the electric motor, and 38 sec. for the direct motor.

A pressing force imposed from the upper side (a dead load is excluded) was 300–400N for the conventional motor and 50–150N for the direct motor **2**.

Test Example 3

Holes H having a diameter of 20 mm and a depth of 130 mm were formed with a cylindrical core bit **13** having a diamond bit **15** in the head end portion thereof, using the conventional electric motor and the direct motor **2**. Perforating times and noise according to different circumferential speeds of the bit **15** were measured, the results of which are shown in FIG. **7**.

Each number of revolution was as follows: 4600 rpm for the direct motor **2**; 1050 rpm for the electric motor.

As is clear from FIG. **7**, it was found that when the rotational speed of the bit **15** was high (250 m/min. or more), the perforating time greatly decreased and the cutting efficiency greatly increased as compared with low rotational speed. The noise at high speed was found to be 10 dB lower than at low speed.

Test Example 4

Holes H having a diameter of 25 mm (bit diameter of 25 mm) and a depth of 200 mm were formed in materials to be perforated comprising concrete in a wet process at a rotational speed of 6000 rpm with two kinds of bits **15** each having a cutting edge thickness of 1.8 mm and 2.0 mm, which were carried out a plurality of times for each bit, and the perforating times were compared.

As shown in FIG. **8**, in the case of a bit **15** having a cutting edge thickness of 1.8 mm, a good cutting performance was always maintained at an increased number of times while a cutting performance sharply deteriorated from around 15th time in the case of a bit **15** having a cutting edge thickness of 2.0 mm.

The edge of each cutter was observed after the tests, the results of which showed that the bit **15** having a cutting edge thickness of 1.8 mm exhibited no remarkable wear while the bit **15** having a cutting edge thickness of 2.0 mm exhibited wear.

As mentioned above, it was found that when a perforation was carried out at high rotational speed (4000 rpm or more), a perforating time could be shortened by using a bit **15** having a thin cutting edge thickness, and that, the wear of the bit was small and a good cutting performance could be always maintained.

This is because of a good spontaneous generation of cutting edge owing to a decreased load imposed on the bit **15**.

Namely, it was found that a tool load imposed on the bit **15** could be decreased when perforation was carried out at high rotational speed, whereby even when a bit **15** having a thin cutting edge thickness was used, any troubles such as buckling were not caused, the perforation could be smoothly carried out while always maintaining a good cutting performance and a further high speed-perforation could be carried out.

What is claimed is:

1. A high-speed perforating apparatus comprising:

a cylindrical core bit having a bit for boring an annular hole in a material to be perforated; and

a motor having a cylindrical stator disposed around the outer periphery of a cylindrical rotor into and through which a rotary shaft is inserted and fixed,

wherein the core bit is directly attached to the rotary shaft of the motor without transmission means and is directly rotated at high speed by the motor, and

wherein the rotary shaft has a coolant supply hole extending along an axis thereof.

2. The high-speed perforating apparatus as claimed in claim **1**, wherein said core bit is rotated by said motor at a high speed which is 400 rpm or more.

3. The high-speed perforating apparatus as claimed in claim **1**, wherein the bit provided to said core bit has an outer diameter of up to 40 mm.

4. The high-speed perforating apparatus as claimed in claim **1**, wherein the bit provided to said core bit has an annular cutting edge having a radial thickness of less than 2 mm.

5. The high-speed perforating apparatus as claimed in claim **1**, wherein an adapter for directly connecting the core bit is mounted to said rotary shaft.

6. The high-speed perforating apparatus as claimed in claim **1**, wherein said rotary shaft is formed in a cylindrical shape and a cooling liquid is introduced from a back end portion of the rotary shaft to a head end portion thereof via the coolant supply hole, to thereby supply the cooling liquid to the bit of the core bit.

7. The high-speed perforating apparatus as claimed in claim **1**, wherein said bit comprises superabrasives and a binder.

8. The high-speed perforating apparatus as claimed in claim **1**, wherein said bit comprises cemented carbides and a binder.

9. The high-speed perforating apparatus as claimed in claim **1**, wherein a coil is provided to said stator of said motor and said rotor of the motor comprises high-density rare-earth magnets selected from the group consisting of neodymium, iron, boron, samarium, and cobalt magnets.

10. The high-speed perforating apparatus as claimed in claim **1**, wherein a coil is provided to said rotor of said motor and said stator of the motor comprises high-density rare-earth magnets selected from the group consisting of neodymium, iron, boron, samarium, and cobalt magnets.

11. A method for perforating at high speed comprising the steps of:

providing for a motor having a cylindrical rotor into and through which a rotary shaft is inserted and fixed and having a cylindrical stator disposed around the outer periphery of the cylindrical rotor, the rotary shaft having a coolant supply hole extending along an axis thereof;

attaching directly to the rotary shaft of the motor a cylindrical core bit having a bit for boring an annular hole in a material to be perforated without transmission means; and

rotating directly the core bit at high speed by rotating the rotary shaft, to thereby bore a hole in the material to be perforated with the bit.

12. The method for perforating at high speed as claimed in claim **11**, wherein said rotary shaft is rotated at a rotational speed of 4000 rpm or more during perforating, to thereby bore a hole in the material to be perforated with the core bit.

13. The method for perforating at high speed as claimed in claim **11**, wherein a bit having an outer diameter of up to 40 mm is used for said core bit.

14. The method for perforating at high speed as claimed in claim **11**, wherein the bit having an annular cutting edge with a radial thickness of less than 2 mm is used for said core bit.

15. The method for perforating at high speed as claimed in claim **11**, wherein the circumferential speed of said bit is 250 m/min or more for perforating.

16. The method for perforating at high speed as claimed in claim **11**, wherein said rotary shaft is formed in a cylindrical shape and a cooling liquid is introduced during perforating from a back end portion of the rotary shaft to a head end portion thereof via the coolant supply hole, to thereby supply the cooling liquid to the bit of the core bit.

17. The method for perforating at high speed as claimed in claim **11**, wherein said bit comprises superabrasives and a binder.

18. The method for perforating at high speed as claimed in claim **11**, wherein said bit comprises cemented carbides and a binder.

19. The method for perforating at high speed as claimed in claim **11**, wherein a coil is provided to said stator of said motor and said rotor of the motor comprises high-density rare-earth magnets selected from the group consisting of neodymium, iron, boron, samarium, and cobalt magnets.

20. The method for perforating at high speed as claimed in claim **11**, wherein a coil is provided to said rotor of said motor and said stator of the motor comprises high-density rare-earth magnets selected from the group consisting of neodymium, iron, boron, samarium, and cobalt magnets.

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